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# CDB5484U Engineering Board and GUI Software

## Features

- Standalone Power Meter Application
- Voltage and Current Interfaces
- Low- and High-voltage Sensor Connections
- Adaptable Sensor Filters Onboard
- USB Communication with PC
- UART/SPI Isolated Communication
- Onboard C8051F342 Microcontroller
- Single Supply Operation from USB or an External +5V DC Supply
- Onboard DC-DC Converter and Regulator
- LCD Power Monitor Display
- LabWindows®/CVI® GUI Software
  - Full Register Setup and Chip Control
  - Simplified Register
  - Quick Calibration Control
  - FFT Analysis
  - Time Domain Analysis
  - Noise Histogram Analysis
- Voltage Reference Access

## General Description

The CDB5484U is an extensive tool designed to evaluate the functionality and performance of Cirrus Logic's CS5484 power/energy measurement device.

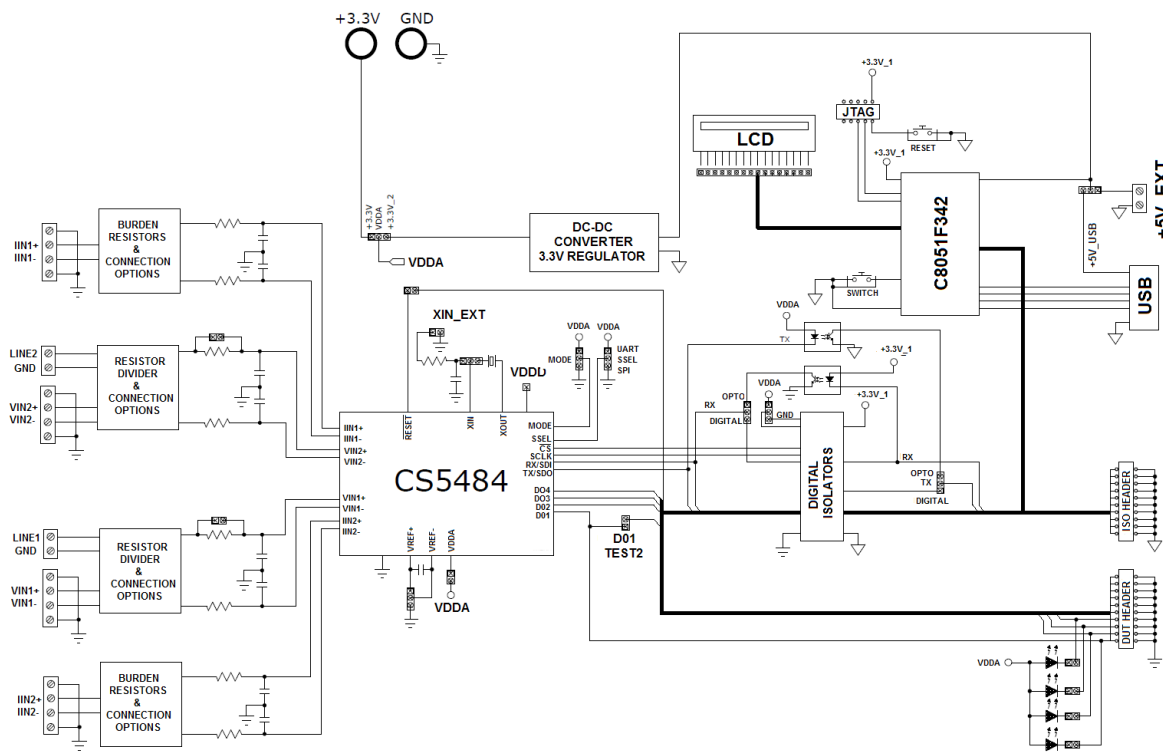
Multiple analog input connection options, configuration input filters, direct and isolated digital interfaces, multiple power supply options, an onboard programmable microcontroller, and visual LEDs with an LCD panel make the board a flexible and powerful customer development tool for various power/energy measurement applications.

The GUI software provides easy and complete access and control to the onboard CS5484 device. It also includes the function of raw ADC data collection with time domain, frequency domain, and histogram analysis.

Schematics in the PADS™ PowerLogic™ format are available on request.

## ORDERING INFORMATION

CDB5484U-Z Evaluation Board





## IMPORTANT SAFETY INSTRUCTIONS


**Read and follow all safety instructions prior to using this demonstration board.**

This Engineering Evaluation Unit or Demonstration Board must only be used for assessing IC performance in a laboratory setting. This product is not intended for any other use or incorporation into products for sale.

This product must only be used by qualified technicians or professionals who are trained in the safety procedures associated with the use of demonstration boards.

### **DANGER** Risk of Electric Shock

- The direct connection to the AC power line and the open and unprotected boards present a serious risk of electric shock and can cause serious injury or death. Extreme caution needs to be exercised while handling this board.
- Avoid contact with the exposed conductor or terminals of components on the board. High voltage is present on exposed conductor and it may be present on terminals of any components directly or indirectly connected to the AC line.
- Dangerous voltages and/or currents may be internally generated and accessible at various points across the board.
- Charged capacitors store high voltage, even after the circuit has been disconnected from the AC line.
- Make sure that the power source is off before wiring any connection. Make sure that all connectors are well connected before the power source is on.
- Follow all laboratory safety procedures established by your employer and relevant safety regulations and guidelines, such as the ones listed under, OSHA General Industry Regulations - Subpart S and NFPA 70E.

 **WARNING** Suitable eye protection must be worn when working with or around demonstration boards. Always comply with your employer's policies regarding the use of personal protective equipment.

 **WARNING** All components and metallic parts may be extremely hot to touch when electrically active.

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## Contacting Cirrus Logic Support

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## 1. HARDWARE

### 1.1 Introduction

The CDB5484U evaluation board provides a convenient means of evaluating the CS5484 energy measurement IC. The CDB5484U evaluation board operates from a single USB or 5V power supply. An optional 3.3V power supply input is available for powering the CS5484 directly. The evaluation board interfaces the CS5484 to a PC via a USB cable. To accomplish this, the board comes equipped with a C8051F342 microcontroller and a USB interface. Additionally, the CDB5484U GUI software provides easy access to the internal registers of the CS5484. The software also provides a means to display the on-chip ADC performance in the time domain or frequency domain.

### 1.2 Evaluation Board Overview

The board is partitioned into two main sections: analog and digital. The analog section consists of the CS5484, passive anti-aliasing filters, and a high-voltage section with attenuation resistor networks. The digital section consists of the C8051F342 microcontroller, LCD, test switches, reset circuitry, and USB interface. The board also has a user-friendly power supply connection. The assembly information and default configurations for jumpers are shown below.

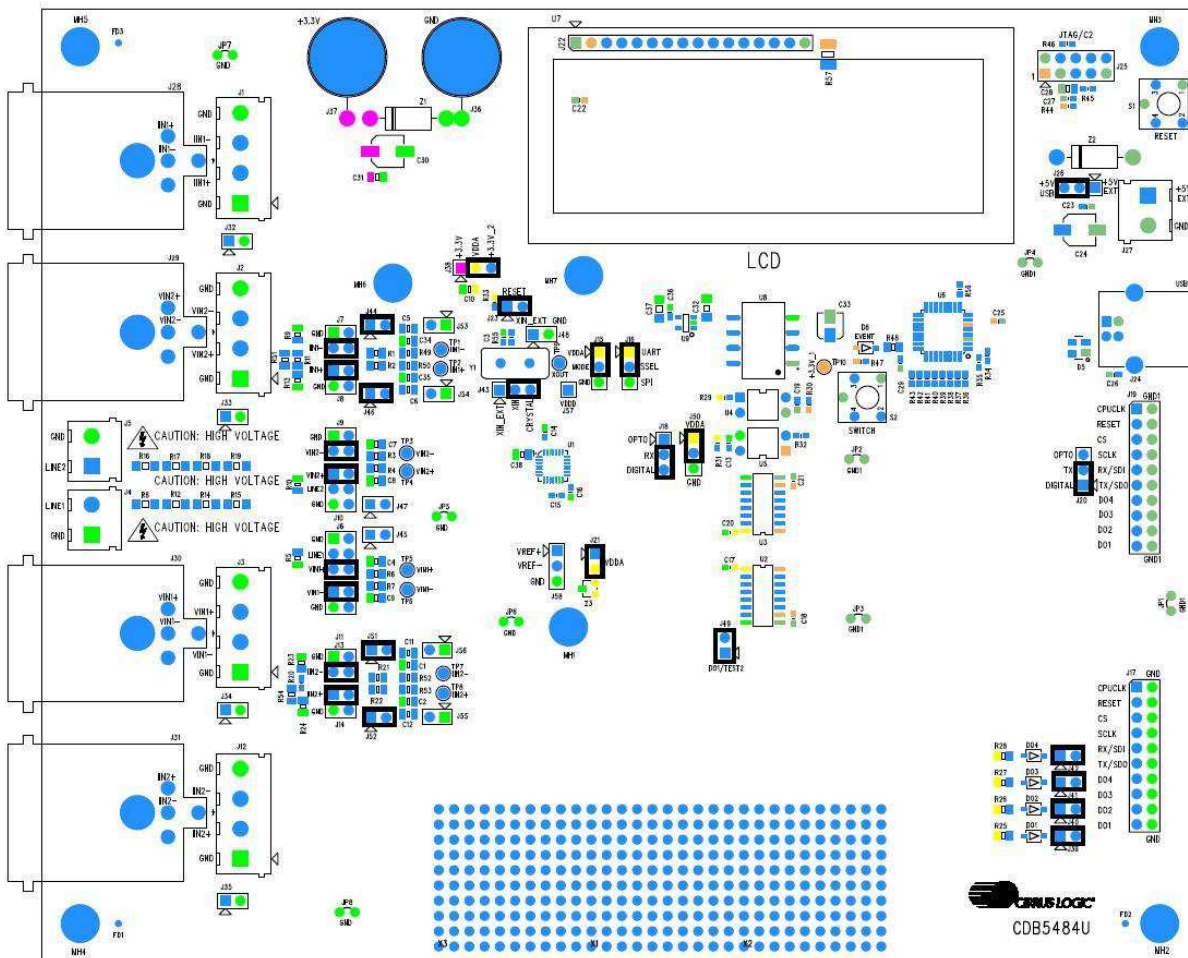


Figure 1. CDB5484U Assembly Drawing and Default Configuration

### 1.3 Analog Section

The analog section of the CDB5484U is highly configurable. Onboard signal conditioning options for the voltage and current channels enable most applications to interface directly to the sensors. The following two sections define the voltage and current channel configurations.

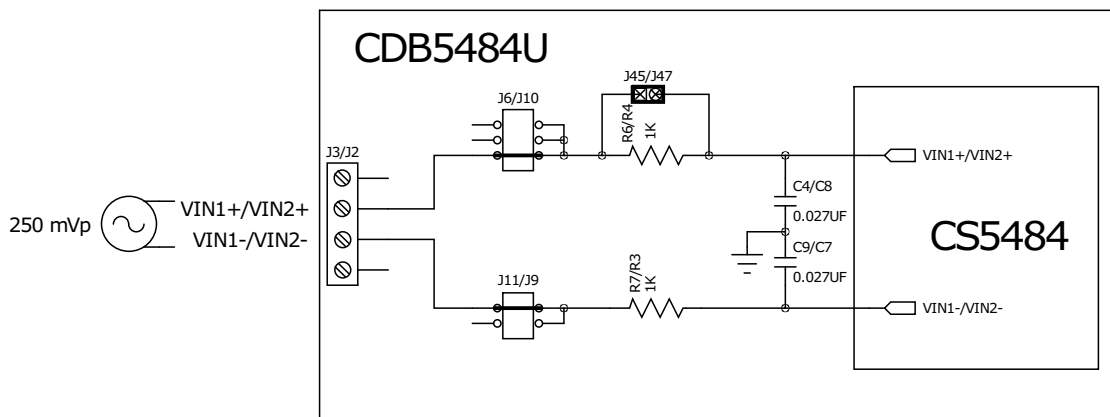
#### 1.3.1 Voltage Sensor Connection

There are three input signal options for the voltage channel inputs (VIN1±, VIN2±) which include an external low-voltage signal (via screw terminals or XLR connections), high-voltage line inputs, or GND. Table 1 illustrates the options available.

**Table 1. Voltage Channel Input Signal Selection**

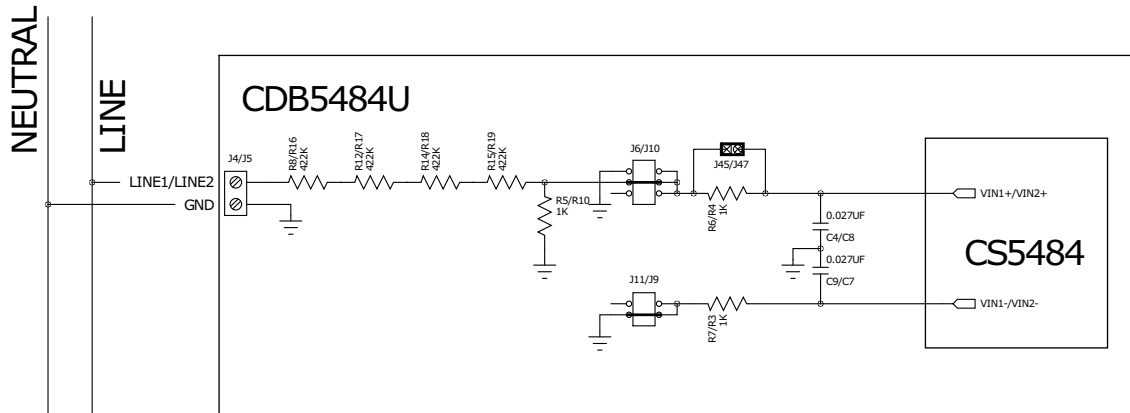
INPUT	Description	J11	J6	J9	J10
VIN1± or VIN2±	Selects External Low-voltage Fully Differential Signal	VIN1- <input checked="" type="checkbox"/> VIN1- GND <input type="checkbox"/> VIN1- <i>(Default)</i>	GND <input type="checkbox"/> VIN1+ Line1 <input type="checkbox"/> VIN1+ VIN1+ <input checked="" type="checkbox"/> VIN1+ <i>(Default)</i>	GND <input type="checkbox"/> VIN2- VIN2- <input checked="" type="checkbox"/> VIN2- <i>(Default)</i>	VIN2+ <input checked="" type="checkbox"/> VIN2+ Line2 <input type="checkbox"/> VIN2+ GND <input type="checkbox"/> VIN2+ <i>(Default)</i>
VIN1± or VIN2±	Selects External Low-voltage Single-ended Signal	VIN1- <input type="checkbox"/> VIN1- GND <input checked="" type="checkbox"/> VIN1- <i>(Default)</i>	GND <input type="checkbox"/> VIN1+ Line1 <input type="checkbox"/> VIN1+ VIN1+ <input checked="" type="checkbox"/> VIN1+ <i>(Default)</i>	GND <input checked="" type="checkbox"/> VIN2- VIN2- <input type="checkbox"/> VIN2- <i>(Default)</i>	VIN2+ <input checked="" type="checkbox"/> VIN2+ Line2 <input type="checkbox"/> VIN2+ GND <input type="checkbox"/> VIN2+ <i>(Default)</i>
GND	Selects Grounding the Input	VIN1- <input type="checkbox"/> VIN1- GND <input checked="" type="checkbox"/> VIN1- <i>(Default)</i>	GND <input checked="" type="checkbox"/> VIN1+ Line1 <input type="checkbox"/> VIN1+ VIN1+ <input type="checkbox"/> VIN1+ <i>(Default)</i>	GND <input checked="" type="checkbox"/> VIN2- VIN2- <input type="checkbox"/> VIN2- <i>(Default)</i>	VIN2+ <input type="checkbox"/> VIN2+ Line2 <input type="checkbox"/> VIN2+ GND <input checked="" type="checkbox"/> VIN2+ <i>(Default)</i>
High Voltage Line1 or Line2	Selects External High-voltage AC Line Signal	VIN1- <input type="checkbox"/> VIN1- GND <input checked="" type="checkbox"/> VIN1- <i>(Default)</i>	GND <input type="checkbox"/> VIN1+ Line1 <input checked="" type="checkbox"/> VIN1+ VIN1+ <input type="checkbox"/> VIN1+ <i>(Default)</i>	GND <input checked="" type="checkbox"/> VIN2- VIN2- <input type="checkbox"/> VIN2- <i>(Default)</i>	VIN2+ <input type="checkbox"/> VIN2+ Line2 <input checked="" type="checkbox"/> VIN2+ GND <input type="checkbox"/> VIN2+ <i>(Default)</i>

The CDB5484U evaluation board provides screw-type terminals (J3 and J2) or XLR connectors (J30 and J29) to connect low-voltage input signals to the voltage channels (see Figure 2). The screw terminals are labeled as VIN1+ / VIN1- and VIN2+ / VIN2-. An R-C network at each channel input provides a simple configurable anti-alias filter. By installing jumpers on J6 to position VIN1+, J11 to position VIN1-, J10 to position VIN2+, and J9 to position VIN2-, the input voltage signal is supplied from the screw terminals or XLR connections.



**Figure 2. Voltage Channel — Low-voltage Input**

The CDB5484U evaluation board provides screw-type terminals (J4 and J5) to connect high-voltage line inputs. By installing jumpers on J6 to position LINE1, J10 to position LINE2, J11 to position GND, and J9 to position GND, the input voltage signal is supplied from the high-voltage inputs. Extreme care should be used when connecting high-voltage signals to the CDB5484U evaluation board (see Figure 3).



**Figure 3. Voltage Channel — High-voltage Input**

The default attenuation networks provide the following attenuation:

$$\frac{1\text{k}}{(4 \times 422\text{k}) + 1\text{k}} = \frac{1}{1689}$$

With the CS5484 input range of 250mVp at a maximum AC line input of:

$$300\text{Vrms} = \frac{250\text{mVp}}{\sqrt{2}} \times 1689$$

is acceptable. It is recommended to apply a 10% margin for the AC line input (270Vrms).

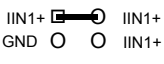
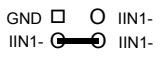
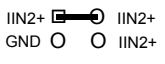
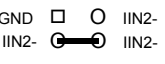
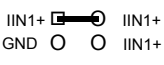
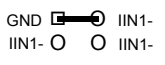
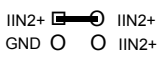
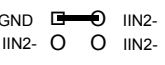

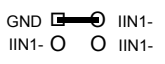

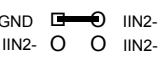
The CDB5484U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J6, J11, J10, and J9 in the GND position, the inputs are connected to analog ground (GND).



### 1.3.2 Current Sensor Connection

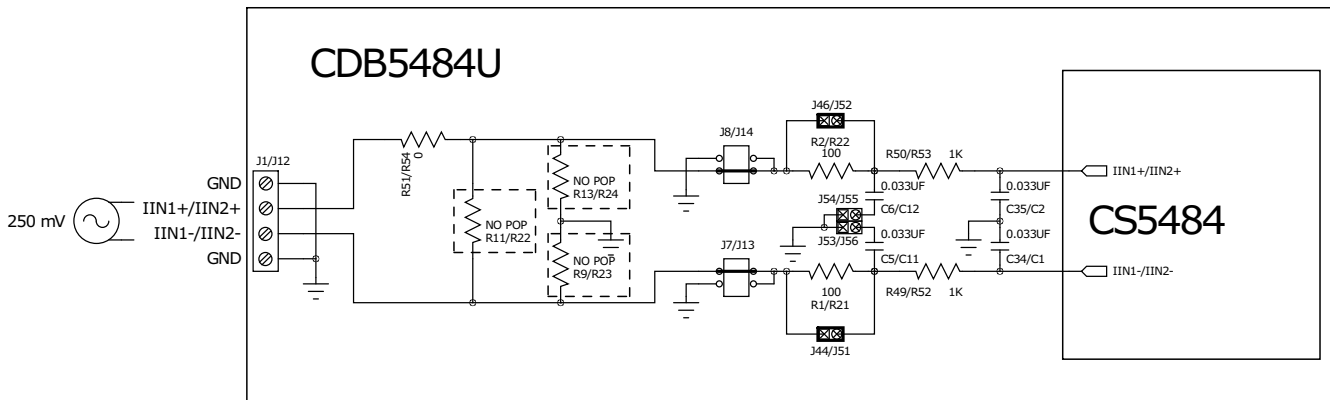
Current input options include an external signal (via screw terminals or XLR connectors) or GND. Table 2 illustrates the options available.

**Table 2. Current Channel Input Signal Selection**

INPUT	Description	J8	J7	J14	J13
IIN1± or IIN2±	Selects External Low-voltage, Fully Differential Signal	 (Default)	 (Default)	 (Default)	 (Default)
IIN1± or IIN2±	Selects External Low-voltage, Single-ended Signal				
GND	Selects Grounding the Input				

The CDB5484U evaluation board provides two input signal options for current channels (IIN1±, IIN2±): screw-type terminals (J1 and J2) or XLR connectors (J28 and J31) to connect input signals to the current channels. The screw terminals are labeled as IIN1+ / IIN1-, and IIN2+ / IIN2-. An R-C network at each channel input provides a simple configurable anti-alias filter.

By installing jumpers on J8 to position IIN1+, J7 to position IIN1-, J14 to position IIN2+, and J13 to position IIN2-, the input current signal is supplied from the screw terminals or XLR connectors.



**Figure 4. Current Channel — Low-voltage Input**

The CDB5484U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J8, J7, J14, and J13 in the GND position, the inputs are connected to analog ground (GND).

## 1.4 Digital Section

The digital section contains the microcontroller, USB interface, LCD, optical isolation, JTAG header, reset circuitry, and external interface headers (J17 and J19). The microcontroller interfaces the UART or SPI of the CS5484 with the USB connection to the PC, enabling the GUI software to access all of the CS5484 registers and functions.

### 1.4.1 Serial Port Selection

Communication to the CS5484 is provided through two serial port options: UART or SPI. It is necessary to establish communication with the MCU before establishing a serial port communication protocol with the CS5484 (see Figure 5).



**Figure 5. MCU Connection Window**

For UART communication, place the SSEL jumper to the *UART* position via J16, and select *UART* in the serial port selection window. To enable SPI communications, place the SSEL jumper to the *SPI* position via J16, and select *SPI* in the serial port selection window. Table 3 provides the serial communication options on the CDB5484U board.

**Table 3. Serial Communication Options**

	J16	J18	J20	J50
UART	<input checked="" type="checkbox"/> UART <input checked="" type="checkbox"/> SSEL <input type="checkbox"/> SPI (default)	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> RX <input checked="" type="checkbox"/> DIGITAL (default)	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> TX <input checked="" type="checkbox"/> DIGITAL (default)	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> EN2 <input type="checkbox"/> GND (default)
SPI	<input type="checkbox"/> UART <input checked="" type="checkbox"/> SSEL <input checked="" type="checkbox"/> SPI	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> RX <input checked="" type="checkbox"/> DIGITAL	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> TX <input checked="" type="checkbox"/> DIGITAL	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> EN2 <input type="checkbox"/> GND
Low speed UART (4800 Baud Max)	<input checked="" type="checkbox"/> UART <input checked="" type="checkbox"/> SSEL <input type="checkbox"/> SPI	<input checked="" type="checkbox"/> OPTO <input checked="" type="checkbox"/> RX <input type="checkbox"/> DIGITAL	<input checked="" type="checkbox"/> OPTO <input checked="" type="checkbox"/> TX <input type="checkbox"/> DIGITAL	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> EN2 <input type="checkbox"/> GND

### 1.4.2 Interface to Microcontroller

Interface headers J17 and J19 are provided to allow the CDB5484U to be connected to an external energy registration device or an external microcontroller. Interface header J17 provides direct access to the CS5484 pins while interface header J19 provides an isolated connection. It is imperative to use the isolated connection (J19) when high-voltage signals are used. Failure to use isolation can result in damage to components or electrical shock. Refer to “Digital Isolation” on page 10 for details on signal isolation.

Interface header J19 can be used to connect to the external microcontroller. To connect the CS5484 to an external microcontroller, R34, R35, R36, R37, R38, R39, R40, R41, R42, and R43 must be removed from the board.

### 1.4.3 Digital Isolation

Two types of isolation are provided, including a low-speed optical coupler for UART-only and high-speed digital isolation for UART and SPI communication. Default jumper settings provide high-speed digital isolators. To enable high-speed digital isolators, place jumpers (J18 and J20) in the *RX to DIGITAL* position and *TX to DIGITAL* position. To enable the high-speed digital isolators, it is also necessary to install jumper (J50) in the *VDDA* position. To enable low-speed optical UART communication, place jumpers (J18 and J20) in the *RX to OPTICAL* position and *TX to OPTICAL* position.

The high-speed digital isolators operate from DC to 150Mbps. The low-speed optical couplers operate to a maximum speed of about 4.8kHz. All the signals supplied to the isolators are available to the MCU except CPUCLK.

### 1.4.4 Additional Device Pin Access

The CS5484’s digital output pins (DO1, DO2, DO3, and DO4) are routed to LEDs, which provide a simple visual check of the digital output. Jumpers J39, J40, J41, and J42 are equipped at the factory with jumpers to enable the LEDs. The DO1 digital output pin is supplied to the digital isolation using jumper J49.

The MODE pin jumper (J15) should be installed in the *VDDA to MODE* position.

The CS5484 system clock can be connected to an onboard quartz crystal, or an external clock can be supplied to the CS5484 XIN pin through jumper J48. To connect the onboard quartz crystal, install jumper J43 in the *XIN to CRYSTAL* position. To connect XIN to an external clock, install jumper J43 in the *XIN to XIN\_EXT* position.

## 1.5 Power Supply Section

Table 4 illustrates the power supply connections on the evaluation board. The positive analog (VDDA) for the CS5484 can be supplied using the +3.3V binding post (J36 and J37) or the onboard +3.3V regulator. Jumper J38 allows the VDDA supply to be sourced from the +3.3V binding post (J37) or the regulated +3.3V supply. The DC-DC converter (U8) powers the onboard +3.3V regulator. Jumper J26 allows the +5V supply to be sourced from either the +5V *EXT* screw connector (J27) or the +5V *USB* supply. The +5V supplies the power for the microcontroller (8051\_REGIN) and the DC-DC converter (U8). Jumper J21 is used to measure the CS5484 analog supply current and **must** be installed.

When connecting the CDB5484U board to the AC line through non-isolated sensors, it is strongly recommended that the CS5484 GND reference is connected to the neutral, the non-isolated current sensor is connected to the neutral, and the CS5484 is supplied by +3.3V isolated from AC line. The DC-DC converter (U8) provides 1kVDC isolation, while no isolation is provided for the 3.3V binding post connections. If +3.3V is used from the binding post, then the external 3.3VDC power supply must be isolated from the AC line. To prevent electric shock and damages, always use an isolated power source.

**Table 4. Power Supply Selection**

Supply Source	CS5484 Source	Binding post J36&J37	USB Supply J24	5V Terminals J27	VDDA		+3.3V_1 J26
					J21	J38	
<b>USB</b>	On-board 3.3 V Regulator	NC	+5V	NC	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA (default)	<input type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> +3.3V_2 (default)	<input type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input checked="" type="checkbox"/> +5V USB (default)
<b>External +3.3V &amp; USB</b>	Binding Post	+3.3 V	+5V	NC	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA	<input checked="" type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input type="checkbox"/> +3.3V_2	<input type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input checked="" type="checkbox"/> +5V USB
<b>External +5V</b>	On-board 3.3V regulator	NC	NC	+5V	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA	<input type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> +3.3V_2	<input checked="" type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input type="checkbox"/> +5V USB

## 1.6 Typical Sensor Connections

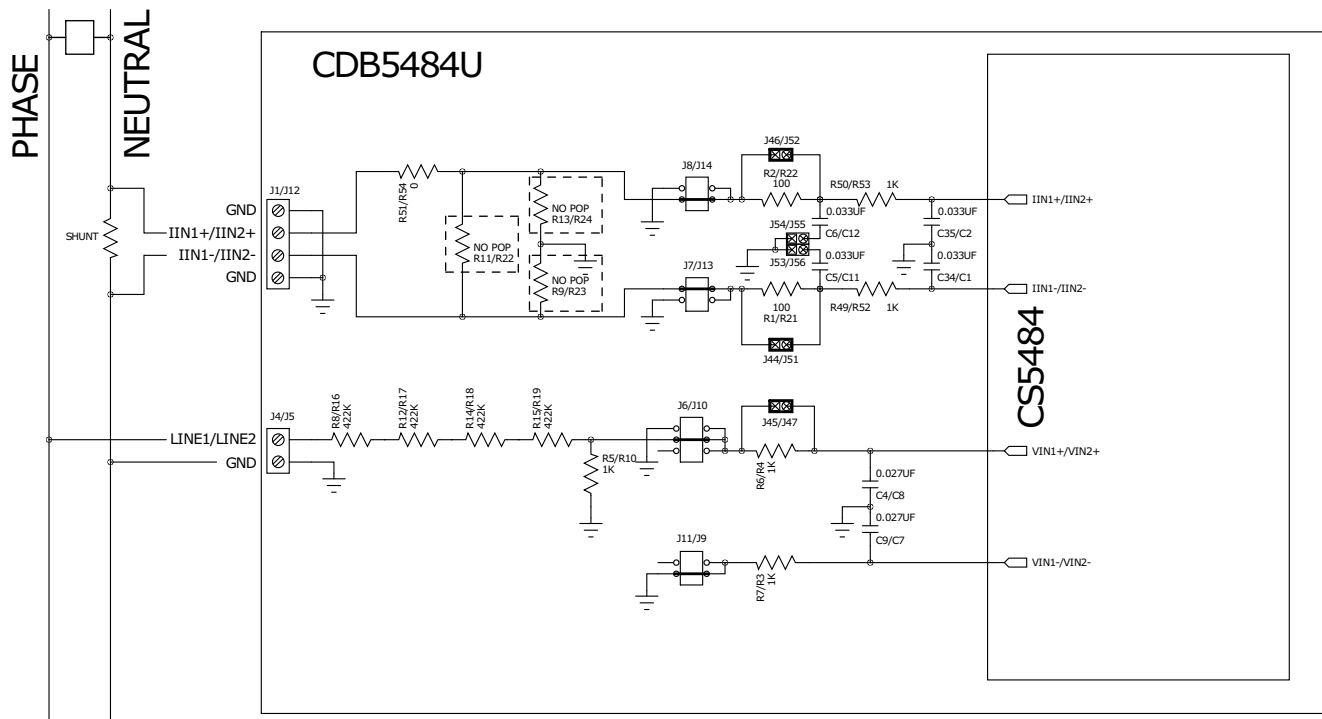
The CDB5484U evaluation board provides connections directly to different types of sensors. Flexible on-board filter networks provide a convenient configuration for three common transducers: current shunt, current transformer (CT), or Rogowski coil.

### 1.6.1 Shunt Power Meter Example

An inexpensive current shunt configuration is easily achievable with the CDB5484U evaluation board. Figure 6 depicts the voltage and current connections for a shunt sensor and its associated filter configurations.

It is strongly recommended that a low-side (neutral path) current shunt is used, especially in high-voltage situations. Make sure that all signals are well connected before the power source is turned on. Extreme care should be taken when connecting high-voltage signals to the CDB5484U evaluation board.

In this configuration it is unnecessary to use a burden resistor. A single anti-alias filter is all that is required for the current channel. Below the filter corner frequency, the CS5484 inputs will see the same voltage that is across the shunt. Therefore the shunt voltage should be kept below the maximum of 50mVp with I-Channel PGA = 50x. A 10% margin is recommended for the shunt voltage (45mVp).



**Figure 6. Shunt Sensor Power Meter**

### 1.6.2 Current Transformer Power Meter Example

A slightly more expensive option is to use a current transformer (CT) to connect the AC current to the CDB5484U evaluation board. Figure 7 depicts the voltage and current connections for a CT sensor and its associated filter configurations.

**NEVER “open circuit” a CT.** Make sure that all signals are well connected before the power source is turned on. Extreme care should be taken when connecting high-voltage signals to the CDB5484U evaluation board.

The burden resistor (R11/R22) is necessary in a CT application to convert the secondary current into voltage. Knowledge of the current transformers turns ratio (N) is key to determining the proper CS5484 input voltage ( $V_{burden}$ ) that the meter places on the system. The optimum secondary voltage ( $V_{burden}$ ) at the maximum current input should be 10% less than the maximum channel voltage of 250mVp with I-channel PGA = 10x. The secondary voltage ( $V_{burden}$ ) is determined by converting the primary current to the secondary current. Then the secondary current ( $I_{burden}$ ) can be converted into a voltage by Ohm's Law.

$$V_{burden} = I_{burden} \times R_{burden} = \frac{I_{primary}}{N} \times R_{burden}$$

The secondary voltage ( $V_{burden}$ ) is sourced to the CS5484 through a simple low-pass, anti-alias filter, and this voltage should not exceed the 250mVp.

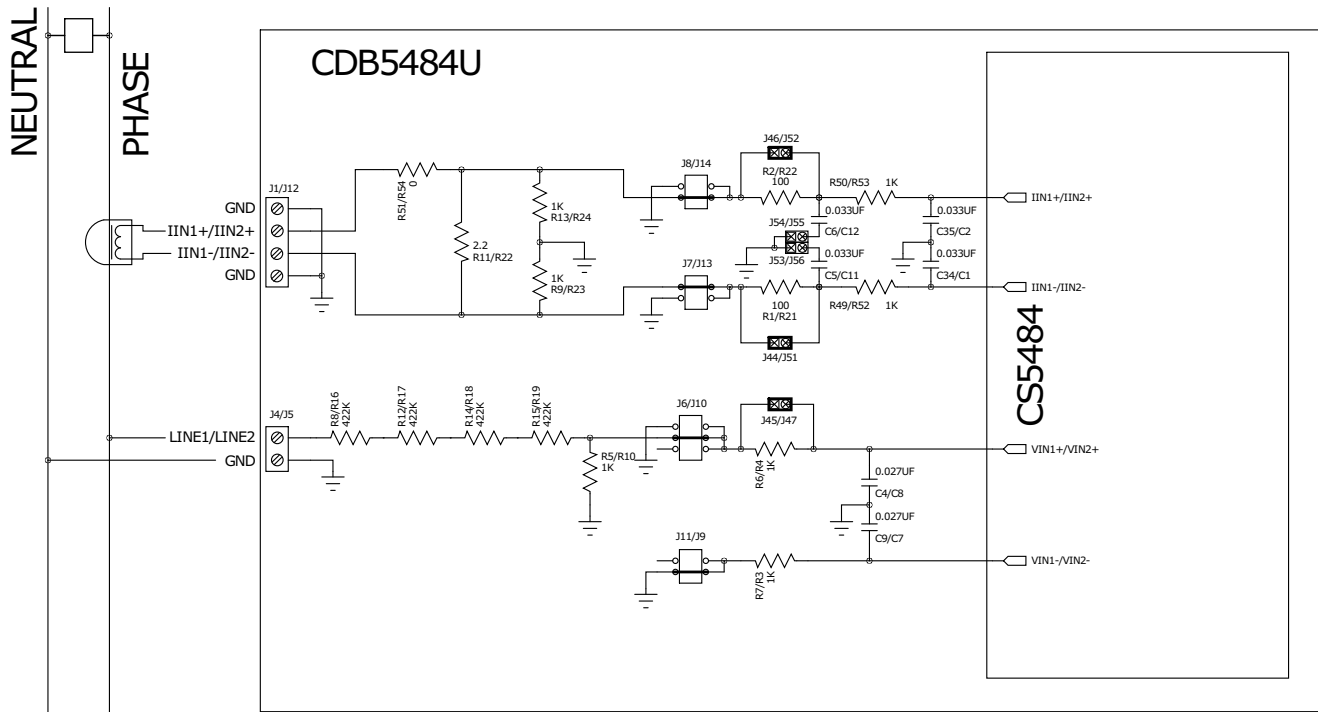
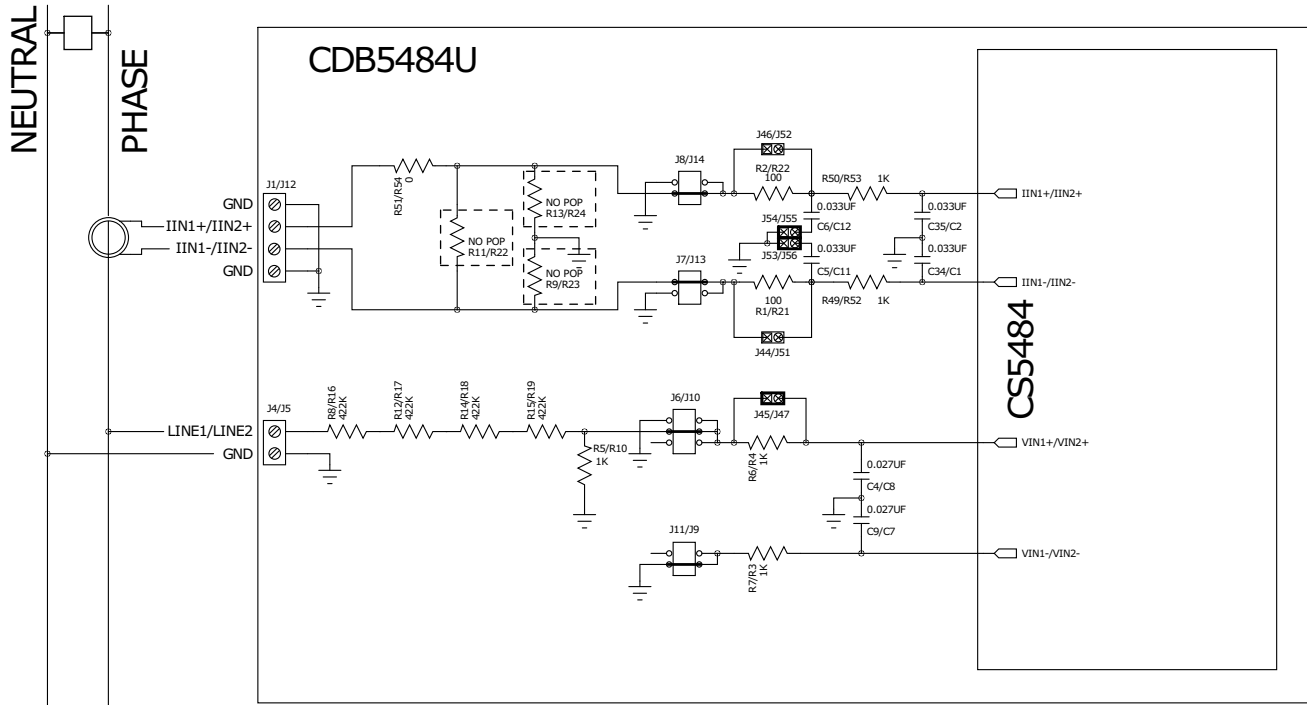


Figure 7. Current Transformer Power Meter

### 1.6.3 Rogowski Coil Power Meter Example

Rogowski coil power meter can be connected to the CDB5484U evaluation board. Figure 8 shows the voltage and current connections for the Rogowski sensor and its associated filter configurations.



**Figure 8. Rogowski Coil Power Meter**

For more information, see AN365: *Using the CS5480/84/90 Energy Measurement IC with Rogowski Coil Current Sensors*.

## 1.7 Standalone Meter Application

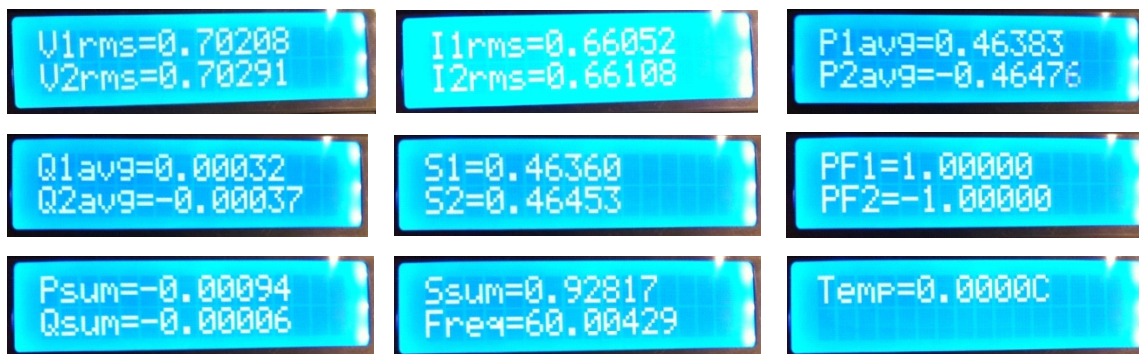
The CDB5484U evaluation board provides a standalone power meter using the CS5484, MCU, and LCD. The user can enable the power meter by connecting the sensors to the analog inputs, providing power to the board, and resetting the MCU by pressing the *RESET* switch. Refer to “Typical Sensor Connections” on page 12 for details on the sensor connections and “Power Supply Section” on page 11 for details on supply options.

The user should not use the GUI to connect the CDB5484U board. Once the GUI is connected to the CDB5484U board the standalone power meter function is disabled and the LCD on the CDB5484U will read "Cirrus Logic CS5484 Eval GUI". To re-enable the standalone power meter feature, close the GUI software. The standalone power meter feature will initially show the voltage channels' RMS register values:

$V1_{rms} = N.NNNNN$  and  $V2_{rms} = N.NNNNN$ .

By clicking the onboard switch S2, the standalone power meter will display the following measurement results:

1. RMS Voltage
2. RMS Current
3. Average Active Power
4. Average Reactive Power
5. Average Apparent Power
6. Power Factors
7. Total Active Power
8. Total Reactive Power
9. Total Apparent Power
10. Fundamental Frequency
11. CS5484 Die Temperature



**Figure 9. Standalone Power Meter Measurements**



## 2. SOFTWARE

The evaluation board comes with software and a USB cable to link the evaluation board to the PC. The evaluation software was developed with LabWindows®/CVI®, a software development package from National Instruments. The evaluation software is designed to run with Windows XP™ and Windows 7™. The following procedure is based on Windows XP.

### 2.1 Installation Procedure

Follow the steps below to install the GUI:

1. Access the following web site: <http://www.cirrus.com/en/support>.
2. Navigate to the **CDB5484U** software link under Energy Measurement. The Software License web page is displayed.
3. To agree with the terms and conditions, click the **Agree** button. The File Download window is displayed.
4. Click the **Save** button. The Save As window is displayed.
5. Select a location to store the compressed folder.
6. Click the **Save** button. The Download complete window is displayed.
7. Click the **Open Folder** button. The location where the compressed folder is stored is displayed.
8. Right-click on the compressed folder, and click **Extract All**.
9. Select a location to extract the files.
10. Navigate to the location where the extracted files are stored and double-click on the **setup.exe** file.
11. Click the **Install** button, and follow the installation instructions.
12. Execute the GUI using Section 2.1.1 *Executing the GUI*.

#### 2.1.1 Executing the GUI

1. From the Start menu, click **All Programs**.
2. Click **Cirrus Energy Measurement Evaluation (CDB5484U)**.
3. Click **CDB5484U**. The GUI is launched.

### 2.2 Using the Software

Before launching the software, check all jumper settings on the CDB5484U evaluation board, as described in “Evaluation Board Overview” on page 5, and connect the board to an open USB port on the PC using the provided cable. Once the board is powered on, the software program can be launched.

## 2.3 Start-up Window

When the software is launched, the Start-Up Window is displayed. This window contains information about the software, including its title, revision number, and copyright date. The Start-Up Window is displayed in Figure 10.

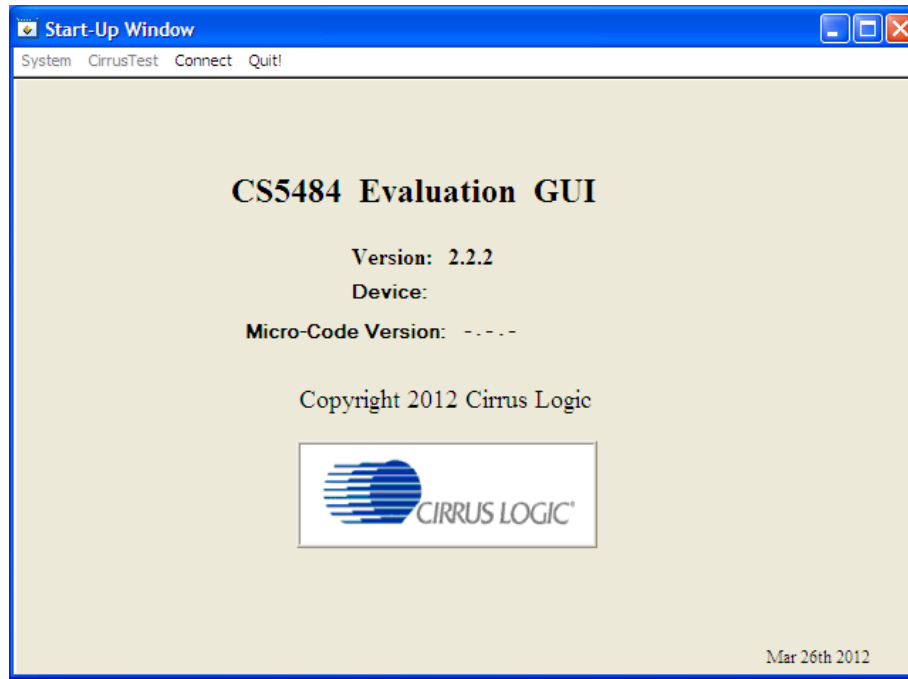


Figure 10. GUI Start-up Window

A menu bar at the top displays four items: *System*, *CIRRUS Test*, *Connect*, and *Quit!*. Initially *System* and *CIRRUS Test* are disabled. After establishing a link to a data source, the *System* and *CIRRUS Test* items will become available.

## 2.4 Connect Menu

The *Connect* menu allows the user to establish a USB communication link with the CDB5484U board. After the USB communication has been established, the CS5484 serial port configuration needs to be entered according to the position of jumper J16. Connecting to the CDB5484 is a two-step process:

1. Use the “USB Item” to connect to the MCU.
2. Use the “CS5484 Serial Port Config Item” to connect the MCU to the CS5484.

### 2.4.1 USB Item

In the *Connect* menu, the USB item allows the user to establish USB communication. If the USB item in the *Connect* menu is selected, the evaluation software will poll the C8051F342 microcontroller, verifying the serial communication link is ready. When the Connect to the CDB board window is displayed (see Figure 11), the user should reset the CDB5484 using switch (S1) on the board, wait for Windows to rec-

ognize the MCU (typically 3 seconds), and then select "OK."



**Figure 11. Connect to the CDB board Window**

At this point, the *USB* menu item is checked, indicating that the PC has successfully communicated with the CDB5484U evaluation board. The micro-code version information are read from the board and displayed on the screen (see Figure 12). Due to improvements to the software or new features being added, the version displayed may be different than the image shown here.



**Figure 12. Connect Menu Showing Successful USB Connection**

If the evaluation software is unable to establish a communication link with the CDB5484U board, a message is displayed, indicating that the initial communication has failed (see Figure 13).

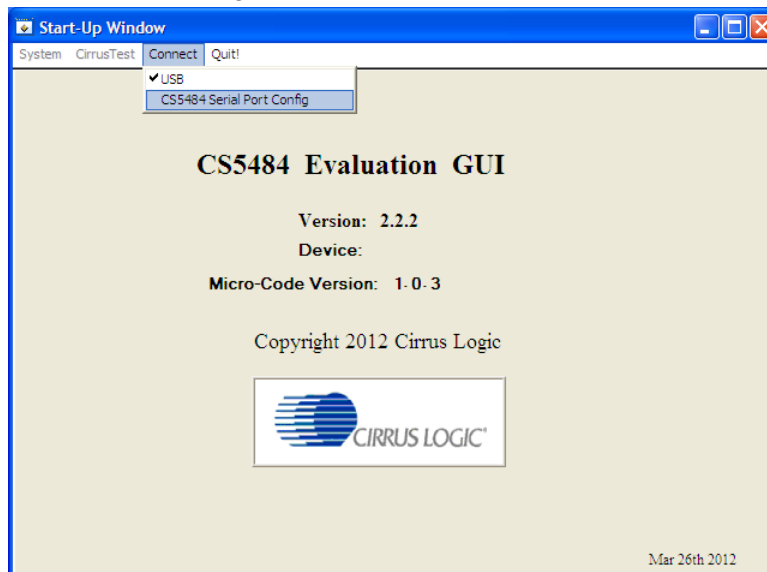


**Figure 13. USB Error Message**

Check to verify that the USB cable is connected properly and the power supply is on and connected properly to the CDB5484U. Reset the board (press the *RESET* button on the board) and try to set up the USB connection again.

### 2.4.2 CS5484 Serial Port Config Item

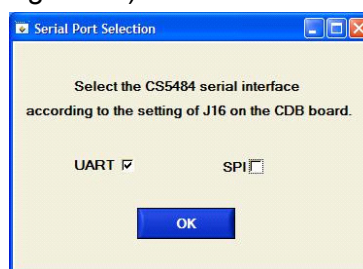
In the *Connect* menu, the *CS5484 Serial Port Config* item allows the user to select different types of serial communication — UART or SPI (see Figure 14).



**Figure 14. Connect Menu Showing Serial Connection Options**

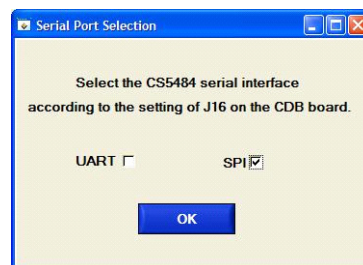
Before the software is configured, it is necessary to set jumper J16 on the CDB5464U board to either the UART or SPI communication. To select UART communication, install jumper J16 in the *SSEL to UART* position. To select SPI communication install jumper J16 in the *SSEL to SPI* position.

To select UART communications, position jumper J16 to the *SSEL to UART* position, and select *UART* in the Serial Port Selection window (see Figure 15).



**Figure 15. UART Serial Port Selection Window, UART Selected**

To select SPI communications, position jumper J16 to the *SSEL to SPI* position, and select *SPI* in the Serial Port Selection window (see Figure 16).



**Figure 16. SPI Serial Port Selection Window, SPI Selected**

After the serial port has been selected, press the OK button. The MCU will try to read the chip ID from the CS5484. The chip revision number will be displayed in the *Device* field in the Start-Up Window. If the *Device* field is populated with "Unknown CHIP ID", the user should check the power supply and clock to the CS5484, *MODE* jumper J15, *SSEL* jumper J16, and the isolation jumpers J18, J51, and J20, click the *RESET* button, and go back to the USB connection process.



Figure 17. Unknown Chip ID Error Message

## 2.5 System Menu

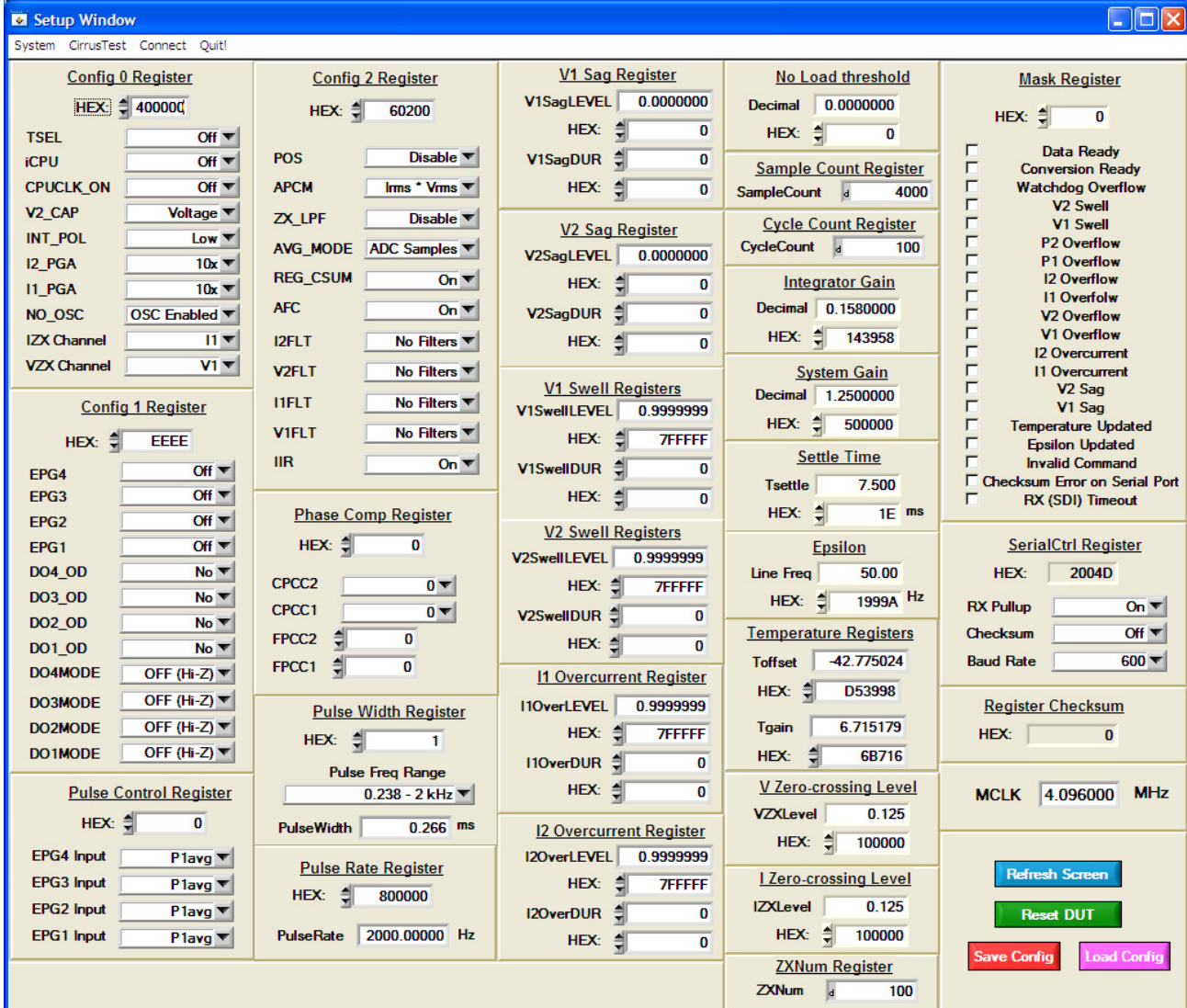
The *System* pull-down provides three options: *Setup CS5484*, *Calibration*, and *Conversion*. Each window provides a means to evaluate the different functions and performance of the CS5484 (see Figure 18).



Figure 18. System Pull-down Options

### 2.5.1 Setup Window

The evaluation software provides access to the common CS5484's internal registers through the Setup Window (see Figure 19). The user can access the Setup Window by selecting the *Setup CS5484* item from the *System* menu.



**Figure 19. Setup Window**

The Setup Window displays all of the common CS5484 registers in hexadecimal notation and are decoded to provide easier readability. Refer to the CS5484 data sheet for information on register functionality and definitions. The Setup Window is segmented by function. Each subsection may contain more than one CS5484 register in order to configure a particular function. Updating the hexadecimal value of a register will change the definitions display according to the new hexadecimal value of the register(s). Likewise, updating the definitions displayed from the list boxes will update the hexadecimal value(s) of the associated register(s).

### 2.5.1.1 Refresh Screen Button

Clicking the *Refresh Screen* button will update the contents of the screen by reading all the register values from the CS5484. It is recommended to click the *Refresh Screen* button when entering the Setup Window, or after modifying any registers, to reflect the current status of the CS5484.

### 2.5.1.2 Reset DUT Button

Clicking the *Reset DUT* button will software-reset the CS5484. The CS5484 will perform a software-reset, as discussed in the CS5484 data sheet. After the software-reset, the screen contents will be automatically refreshed with the updated status of the CS5484.

### 2.5.1.3 Save Config and Load Config Buttons

Clicking the *Save Config* button will save the current setup window's configuration to a .txt file. Clicking the *Load Config* button will recall a saved configuration and store values into the CS5484.

### 2.5.1.4 CS5484 MCLK Frequency

The CS5484 accepts a wide range of MCLK input frequencies and can therefore run at many different sample rates. The frequency being used on the CS5484 should be entered in this box to provide accurate frequency calculation in the FFT window. This will also help the software decide which functions the evaluation system can perform reliably.

### 2.5.1.5 Configuration Registers

In the *Config0*, *Config1*, and *Config2* register boxes, the contents of the CS5484's configuration registers can be modified by typing a hexadecimal value in the *HEX* field, or by changing any of the values below the *HEX* field to the desired settings. Although the CDB5484U software allows the user to modify any of the bits in the configuration registers, changing certain reserved bits, such as the *NO\_OSC* bit of *Config0*, may cause the software and board to behave erratically. This applies only to the CDB5484U evaluation system, and not to the CS5484 chip itself.

### 2.5.1.6 Pulse Control Register

The *Pulse Control Register* section is used to make changes to, and display the contents of, the CS5484's *PulseCtrl* register. The *PulseCtrl* register contains various bits used to select the input to each energy pulse generation block within the CS5484. Refer to the CS5484 data sheet for descriptions of the bits. The value of the *PulseCtrl* register is displayed in hexadecimal format. Most of the *PulseCtrl* register bits are reserved or unused. Only the usable bits are displayed in the Setup Window.

### 2.5.1.7 Pulse Width and Pulse Rate Registers

The *Pulse Width Register* section is used to make changes to and display the contents of the CS5484's *PulseWidth* register. The *PulseWidth* register is used to define the frequency range and pulse width of the energy pulses generated by the CS5484. The *PulseWidth* register should be configured before setting the *PulseRate* register. The *Pulse Rate Register* section is used to make changes to and display the contents of the CS5484's *PulseRate* register. The *PulseRate* register defines the full-scale frequency of the energy pulses generated by the CS5484.



#### 2.5.1.8 Phase Compensation

The *Phase Comp Register* section is used to make changes to, and display the contents of, the CS5484's *PC* (Phase Compensation Control) register. The *PC* register allows coarse- and fine-phase adjustment on each channel of the CS5484 data path. Refer to the CS5484 data sheet for descriptions of the *PC* register bits.

#### 2.5.1.9 Integrator Gain, System Gain

The *Integrator Gain* and *System Gain* sections display the signal path gain in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding *Decimal* or *HEX* field.

#### 2.5.1.10 Sample Count, Cycle Count, Settle Time

The *Sample Count Register*, *Cycle Count Register*, and *Settle Time* sections provide fields to display the values of registers associated with low-rate calculations. The *SampleCount* and *CycleCount* registers are entered or displayed in decimal format by default. The user may select to enter or view other number formats of the register by selecting the "d" within the field. The value of the  $T_{Settle}$  register is displayed in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding field.

#### 2.5.1.11 Epsilon

The *Epsilon* section is used to display and adjust the *Epsilon* register (the ratio of the AC line frequency to the output word rate). The *Epsilon* register can be updated either through entering the AC line frequency in the *Line Freq* field or by entering the direct register value in the *HEX* field.

#### 2.5.1.12 ZX<sub>NUM</sub>

When Automatic Frequency Update is enabled, the *ZX<sub>NUM</sub>* section is used to adjust the number of zero crossings used in the *Epsilon* calculation. The update rate of *Epsilon* is increased by reducing the zero crossings. The register can be modified by typing the number of zero crossings.

#### 2.5.1.13 Mask Register

The *Mask Register* box displays the value for the *Mask* register in hexadecimal and decodes them to indicate each bit's function. The *Mask* register can be modified by typing a value in the *HEX* field, or by checking the appropriate boxes for the bits that are to be masked. The value present in the *Mask* register may be changed by the GUI software during certain operations to provide correct functionality of the CDB5484U board.

#### 2.5.1.14 Temperature Registers

The *Temperature Registers* box is used to adjust the temperature offset register ( $T_{OFF}$ ) and temperature gain register ( $T_{GAIN}$ ) to convert the temperature register ( $T$ ) from the Celsius scale to the Fahrenheit scale, or vice versa, and to improve temperature measurement accuracy. Refer to the CS5484 data sheet for the details of the on-chip temperature sensor.

#### 2.5.1.15 V/I Zero-crossing Level and No Load Threshold

The *V/I Zero-crossing Level* and *No Load Threshold* boxes display the values for these registers in hexadecimal and decimal. Each register can be modified by typing a value in the corresponding *Decimal* or *HEX* field.

### 2.5.1.16 V1/V2 Sag, V1/V2 Swell, and I1/I2 Overcurrent Registers

The registers for voltage sag, voltage swell, and overcurrent are displayed in the *V1 Sag*, *V2 Sag*, *V1 Swell*, *V2 Swell*, *I1 Overcurrent*, and *I2 Overcurrent Register* sections. These sections display the level and duration values of the corresponding registers in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding decimal or *HEX* field. Refer to the CS5484 data sheet for detailed descriptions of these registers.

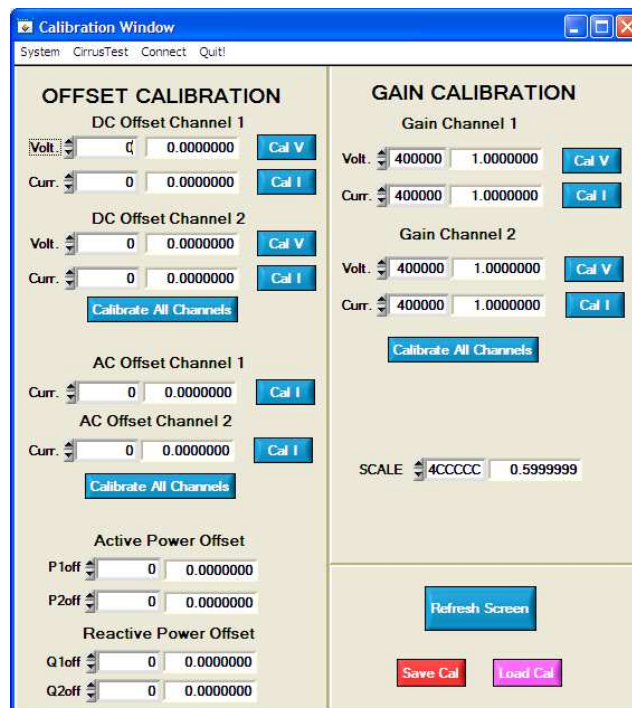
### 2.5.1.17 Register Checksum, SerialCtrl Registers

The *Register Checksum* and *SerialCtrl Register* boxes provide control and status of critical serial port communication parameters and the register checksum. The *SerialCtrl Register* section provides control over RX pin, baud rate, and enabling checksum protection for serial communication. The *Register Checksum* section provides the calculated checksum of the critical registers inside the CS5484. The register checksum updates automatically after single or continuous conversion has been performed. The *RegChk* and *SerialCtrl* registers are displayed in hexadecimal form. Note that if the opto-couplers are selected as the isolation (J18, J20), the maximum baud rate is 2400.

The baud rate field applies only to UART serial communication and can be changed by the pull-down field. It is recommended to set the baud rate to the highest setting possible. The default setting of 600 baud will cause some GUI functions to overflow the communication buffer and not function correctly.

## 2.6 Calibration Window

The Calibration Window is used to display and write to the CS5484 offset and gain calibration registers. The user is also able to initiate the CS5484's calibration sequences that are used to set the calibration values. AC offset, DC offset, and gain calibrations can be performed on the voltage channel, the current channel, or both simultaneously. The user should refer to the CS5484 data sheet for more details on calibration (see Figure 20).



**Figure 20. Calibration Window**